Chapter 4
Environmental Effects of Beach Nourishment Projects

A beach nourishment project is a type of storm damage reduction project that involves placing sand on a beach, or along a shoreline to widen the area and increase the volume of sand available to absorb and dissipate wave energy. Sand is usually dredged from a borrow site and deposited on the eroding shoreline. The re-nourished beach is considered a "soft" or nonpermanent design profile that will require periodic renourishment to continue to provide storm damage reduction. Beach nourishment has the virtue of being "...the only engineered shore protection alternative that directly addresses the problem of a sand budget deficit..." by adding sand to an eroding system and maintaining the natural littoral sand balance. (NRC, 1995)

Periodic renourishment often has beneficial environmental effects. A renourished beach can provide new nesting area for sea turtles, spawning grounds for horseshoe crabs and habitat for piping plover and least terns. In some cases, beach nourishment projects are formulated for the primary purpose of environmental restoration. For example, a project designed for Reeds Beach and Pierces Point, N.J., along the Delaware Bay coastline, was formulated to provide a beach berm that will result in 17 acres of habitat for horseshoe crabs, shorebirds and migratory birds. Without nourishment, it is projected that this area will lose 21 acres of fish and wildlife habitat to erosion over the upcoming 50 years. Erosion at a rate of one foot per year would reduce spawning habitat for horseshoe crabs. In turn, migratory birds, which feed on horseshoe crab eggs, would lose an important food source.

The plant and animal species existing in littoral areas are adapted to survive in the dynamic environment created by the natural cycle of sand erosion and accretion. Beach nourishment, however, accelerates certain dynamic processes, and taxes the capacity of benthic species to adapt. More importantly, however, negative impacts on the plant and

animal species that inhabit the subaerial and subtidal zones can largely be avoided by adhering to appropriate management practices, as specified in Corps regulations and project planning guidance, in compliance with state and federal environmental statutes and regulations. From its many years of involvement in these types of projects, the Corps has developed extensive expertise and general procedures for avoiding adverse environmental consequences of beach nourishment. Many Corps regulations and planning guidances provide guidelines for utilizing suitable practices. Some of the most directly pertinent include engineering regulations ER 200-2-2 Procedures for Implementing NEPA and ER 1105-2-100, Guidance for Conducting Civil Works Planning Studies. Engineering manuals, EM 1110-2-1204, Environmental Engineering for Coastal Protection and EM 1110-2-1004, Coastal Project Monitoring, also provides guidelines for conducting environmental studies, monitoring the effects of coastal projects and avoiding damages to the environment. Additionally, all Corps projects are required to comply with Federal environmental statutes and regulations, including the following described in Table 4.1.

This section will look at the three regions that are affected by beach nourishment activities, the subaerial zone, the subtidal zone and the borrow site. The subaerial zone includes those areas of the beach that are visible above the mean low tide line. The subaerial zone consists of two, distinct zones, the supralittoral zone, which is the dry part of a beach that lies beyond the reach of the average high tide, and the intertidal zone, which is the part of the beach that lies between the average high tide and low tide marks.

The physical changes that occur in these three areas during the course of nourishment activities will be described, as well as management practices used in Corps projects to prevent possible effects on the biota that inhabit these areas. Specific reference will be made to a seven-year biological monitoring program recently completed by the New York District of the Corps and the State of New Jersey. (Corps, 2001) The biological monitoring program (hereafter referred to as "the New Jersey study") was initiated in 1993 and examined six reaches of high energy beaches extending along the New Jersey shore to identify any adverse or beneficial effects of beach nourishment in both the borrow area (dredged area) and beach area. Nourishment projects were

conducted during the study period along reaches extending from Manasquan Inlet to Shark River, and from Shark River Inlet to Asbury Park. One beach, extending from Asbury Park to the northern edge of Deal remained untouched during the course of the study, acting as a control site. The study findings are the most recent and most extensive results available documenting the environmental benefits and costs of beach nourishment projects.

Table 4.1: Federal Statutes Relevant to Beach Nourishment Projects[39]

Federal Statute	*Description*
National Environmental Policy Act of 1969 (Public Law 91-190)	Requires coordination between the Corps of Engineers districts and Federal, state county and municipal agencies concerning any environmental impacts of a beach nourishment project.
Coastal Zone Management Act of 1972 (Public Law 92-593)	Requires that any proposed dredging activity comply with the Federal Coastal Zone Management Program.
The Endangered Species Act	Requires all Federal agencies to seek to conserve endangered and threatened species and to utilize their authorities in furtherance of the purposes of the Act, i.e. to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved and to provide a program for the conservation of such endangered and threatened species.
Clean Water Act of 1977 (Public Law 95-217)	Requires that an evaluation in compliance with Section 404 of this act be included in all Environmental Impact Statements.

4.1 Subaerial Zone

Biota found in subaerial zone: The subaerial zone includes both the supralittoral zone, the dry area of the beach above mean high tide, and the intertidal zone, the wet part of the beach that falls between the mean high and low tide lines. Animal life found on a sandy beach include burrowing species, such as talitrid and haustoriid

[39] Information taken from IWR Report 96-PS-1, Shoreline Protection and Beach Erosion Control Study Final Report: An analysis of the U.S. Army Corps of Engineers Shore Protection Program.

amphipod species and, in southern beaches, ghost crabs. Animal species in the intertidal zone include haustoriid amphipods, polychaetes, isopods, mollusks, large crustaceans, such as mole crabs and burrowing shrimp. The biological monitoring program conducted along the New Jersey shore found that species inhabiting the intertidal area included species of rhynchocoels, polychaetes, oligochaetes, mole crabs and haustoriid amphipods.

Physical changes that occur with nourishment: With beach nourishment, the largest amount of sand is placed in the supralittoral and intertidal zones. To a certain extent, this dispersal of sand mimics the naturally occurring process of sand deposition; except that sand is generally spread over a larger area and at greater depths than might naturally occur. Generally, the greatest amount of sand is distributed across the upper reaches of the beach, an area where the diversity and abundance of animal and plant life are relatively limited. However, the amount of sand flowing from the supralittoral zone into the intertidal zone can be substantial, ranging anywhere from centimeters to more than a meter.

Corp projects utilize a variety of management practices designed to ensure that the physical attributes of the sand used in a beach nourishment project are suitable and will not detrimentally affect the environment. Beach nourishment can alter sand compaction, shear resistance, moisture content, grain size and shape, and initially increases the slope of the beach. A study by Peterson et.al. (2000) examining the physical consequences of beach nourishment on the beaches of Bogue Banks, a barrier island along the North Carolina coast, observed that 5-10 weeks after completion of the nourishment activity, the intertidal areas were somewhat more compacted (surface was harder) and the color of the beach was gray rather than the brownish white of the existing beach. Other physical changes to the beach may result depending upon the type of sand used as fill material.

Corps management practices include monitoring for sand compaction and, where warranted, tilling the beach to offset compaction. Consideration of sand compaction is also made in the selection of fill material, with the use of coarse, round sand to reduce

beach hardness. Ideally projects will use sand that is similar in its composition and coarseness to sand on the existing beach. Corps regulations emphasize that the sources of beach fill must be similar in terms of grain size to the existing sand on the beach. Generally, fine-grained, silty materials are avoided as fill material. Sand that has a high content of fine-grained clay or silty material can result in excessive turbidity and sedimentation, which will detrimentally impact underwater plant and animals.

Effects on biota in subaerial zone: One potential effect of beach nourishment closely studied is the consequences of sand burial on burrowing species. Animal life on sandy beaches is generally well adapted to the dynamic environment of a littoral area. However, if the volume of sand distributed across the beach is too great, organisms burrowing in the beach can be smothered, unless they can dig through the additional sand, or leave the area altogether. (NRC, 1995) Adriaanse and Coosen (1991) state that most benthic species will die if covered by sediment at a depth of 0.5m or more. Depths ranging from 0.01 to 0.5m will allow a limited number of species to burrow up through the additional sand and avoid suffocation. (Adriaanse, 1991)

Overall, the studies reviewed found that beach nourishment may result in the short-term loss of burrowing species due to smothering or abandonment. However, study results also show that these infaunal populations (i.e. organisms living in sediments on the ocean floor) recover over a relatively short period of time, ranging from a few weeks, to a few months (NRC, 1995)

Authors of the 1995 review warn that some of the sampling techniques used in these studies were flawed. In some cases, the number of samples collected was limited, or the frequency and length of time over which sampling took place was insufficient. (NRC, 1995) Nevertheless, the New Jersey study, the most comprehensive long-term study available, supports the general finding that there are no long-term impacts on infaunal populations. During the course of the New Jersey monitoring program, several intertidal infaunal assemblages were examined, including rhynchocoels, polychaetes, including *Scolelepis squamata*, *Protodriloides*, and *Microphthalmus*, mole crabs and

several haustoriid amphipods. (NJ, 2001) The results of the monitoring indicated that these infaunal assemblages incurred only short-term declines in abundance, biomass and diversity. The period of recovery lasted from only 2 – 6.5 months. Recovery periods at the upper end of this range generally occurred when beach nourishment activities were completed at the low point in the seasonal cycle of infaunal abundance. The New Jersey study concludes that monitoring results show no significant long-term impacts of beach nourishment activities on intertidal infaunal species.

It has been suggested that even a temporary loss of infaunal species can have secondary short-term effects on the bird and marine life that rely on such species as a food source. No studies were found examining the effects of beach nourishment on the feeding patterns of birds, fish and other marine life that rely on infaunal food sources. However, discussions with biologists in the Jacksonville District Corps offices indicated that, because the recovery period for benthic species has proven to be short, there is limited concern over loss of food sources. Additionally, the new material deposited on the beach with a nourishment activity often brings new organisms with it, providing a substitute food source.

Beach nourishment may have beneficial environmental effects on the supralittoral zone, by providing enhanced nesting habitat for endangered sea turtle species, including the loggerhead, leatherback and green turtles. These sea turtle species emerge from the ocean at night to lay their eggs in the supralittoral zone. By enhancing the supralittoral zone, beach nourishment can help restore nesting habitat for the turtles.

Selection of appropriate sand for beach renourishment is important to maintaining suitable nesting habitat. Physical changes in sand attributes, such as texture, moisture content, temperature, gas diffusion rates and organic matter can all interfere with successful sea turtle nesting. (Hillyer, 1996) If the sand texture is not fine enough to maintain the structure of the nest, the nest will collapse and the emerging hatchlings are unable to reach the surface. If sand texture is too fine, the rate of gas diffusion is inhibited, arresting embryonic development. A change in sand color can affect the

amount of heat absorbed from the sunlight, altering the temperature of the nesting site. Changing beach temperatures effect nest site selection, incubation duration, sex ratio and hatchling success rates. Sand moisture levels can also interfere with successful hatching and emergence of juvenile turtles.

As was previously described, it is standard practice on Corps projects to select sand that is a close match to the existing beach material, or is an improvement upon the existing materials in terms of creating suitable habitat. Additionally, methods of spreading the sand immediately following nourishment to approach an equilibrium profile have been used to reduce the development of scarps that might act as barriers to sea turtles. A 1995 review of beach nourishment studies described several monitoring programs examining the effects of beach nourishment on turtle hatchling survival. In general, these studies have found no significant difference between hatching and emergence success on nourished and unnourished beaches. (NRC, 1995) In fact, the results of one study suggested that hatchling success and hatchling weights improved on a nourished beach in Boca Raton, Florida, compared to an adjacent, unnourished beach. (NRC, 1995)

In addition to creating nesting areas for sea turtles, beach nourishment projects have benefited other species, for example, by providing spawning grounds for horseshoe crabs and habitat for piping plover. Another example is a nourishment project recently completed on Faulkner Island, Connecticut. The re-nourished beach created habitat for terns, and the US Fish and Wildlife Service reported an additional 600+ more common tern nests than were found last year, prior to construction. Other management practices are employed in Corps projects to minimize interference with beach animals, including the planting of beach plants to replace damaged plants and create pedestrian barriers, conducting construction activities in fall and winter season when nesting and spawning season is past and many animals have migrated out of the area, minimizing vehicle use, limiting lighting of the beach, reducing storage of piping on the beach and locating the pipeline parallel to the beach and as distant from the high tide line as possible to reduce disturbance of beach animals.

4.2 Subtidal zone

Biota found in subtidal zone: Animal and plant life found in the subtidal zone adjacent to the beach include benthic invertebrate (i.e. invertebrates living on or beneath the ocean floor), epifaunal invertebrate (i.e. invertebrates living in the sediments on the floor of the ocean), reef communities and the fish and crustaceans that feed on or live in these habitats. Infaunal macroinvertebrates include polychaetes, amphipods, isopods, decapods, polychaets, mollusks, and echinoderms. Many of the epibenthic invertebrates (i.e. invertebrates living above the sea floor) and finfish species found in the nearshore area (i.e. the area seaward of the zone of breaking waves, referred to as the surfzone) are commercially valuable, such as several shrimp species found in the Gulf coast area. Reef habitats found along the Florida coastline include sessile species (i.e. organisms that are permanently affixed in one place and immobile) including sponges, octocorals, hard corals, hydrozoans, bryozoans, ascideans and algae that grows on these other organisms. Reef habitats also include epibenthic invertebrate and finfish species that forage and seek shelter in the reefs.

Animal life in the nearshore area examined in the New Jersey study included the wedge clam, polychaetes (Magelona papillicornis and Asabellides oculata), bivalves (Spisula solidissima and Tellina agilis) and amphipods (Acanthohaustorius millsi and Psammonys nobilis). Fish larva found in the nearshore and surfzone area included 33 families of fish.

Physical changes that occur with nourishment: Generally, most of the sand deposited during a beach nourishment project is distributed on the supralittoral and subtidal areas of the beach; however, some shallow, underwater habitats can also be buried. If appropriate management practices are not used, beach nourishment can physically alter both sand-bottom habitats and reefs by sand burial as the beach expands with nourishment. Other physical alterations to the subtidal zone include increased sedimentation beyond the surf zone as sand filters back into the sea, changes in the depth and surface features of the ocean floor that may also alter wave action and increased

turbidity. The movement of sand off of the nourished beach into the surf zone can have the beneficial effect of providing additional sand supply for surrounding beaches, outside of the project area. However, the down-flow of sand can also result in increased sedimentation in areas beyond the surf zone in the nearshore zone, particularly if the fill material consists of a high percentage of silt and clay material.

Effects on biota in subtidal zone: Marine communities in the subtidal zone are generally not as well adapted to endure the consequences of sand accretion and erosion as are organisms found in the supralittoral and intertidal zone. Mobile invertebrates and fish in the nearshore zone should be able to avoid the direct effects of a nourishment project, simply by migrating outside of the immediate area. Fish larva in the surf zone, however, may be damaged by increased turbidity. Also, sessile species of plants and animals found in hard bottom reefs or in sea grass beds are vulnerable to turbidity. Increased sedimentation can impair the filter-feeding process used by many of these organisms, inhibit photosynthesis, or smother the organisms. (NRC, 1995)

While some marine organisms found in the subtidal zone are vulnerable to the effects of turbidity, studies reviewed indicated that the effects of beach nourishment projects in the subtidal zone have been limited and short-term. The New Jersey study monitored changes in turbidity and sedimentation associated with beach nourishment activities. It was found that beach nourishment did result in short-term increases in turbidity with suspended sediments prominent in the swash zone in the immediate area of the project operations; however, sediment concentrations dispersed rapidly. Elsewhere, any short-term turbidity effects rarely exceeded 25 milligrams per liter. The study points out that this amount is comparable to the concentrations found in estuaries or produced during storms.

Two surveys of fish populations in Florida conducted before and after beach nourishment indicated that beach nourishment had no damaging effects on the composition and abundance of the fish sampled. (NRC, 1995) A 1995 review of studies examining the environmental effects of beach nourishment indicates that no studies have

been conducted examining the effects of nourishment on crustacean populations in the nearshore area, such as penaeid shrimps. (NRC, 1995)

The 1995 review also describes the findings of a series of studies examining the effects of beach nourishment activities on nearshore soft bottom community. Results of these studies suggest that nourishment activities have only limited, short-term effects. However, the book notes that many of these studies had inadequate sampling designs that could result in the underestimation of beach nourishment impacts. (NRC, 1995)

In the surf zone, the New Jersey study found that beach nourishment had the short-term effect in one beach nourishment location of reducing the abundance of bluefin and increasing the number of benthic feeders. The study concludes that these changes occurred along with the suspension of benthic material associated with beach nourishment disturbances. In the long-term, however, the study finds that neither finfish abundance nor distribution differed in the nourished beach surfzone areas.

The New Jersey study also monitored the effects of beach nourishment on the composition and availability of food sources for kingfish and silversides over a two-year period following completion of a beach nourishment project. The study found no negative impacts on the availability of food sources or foraging success for kingfish or silversides. No differences were observed in the composition of food sources for kingfish or silversides in the nourished and non-nourished beach areas, based on an examination of the composition prey biomass. Nor was there a difference in the number of fish found with filled stomachs.

A similar examination was made of the food sources for bottom feeding fish, including winter flounder, summer flounder and scup. No significant difference attributable to beach nourishment was detected in the quantity or composition of the food supply for these fish species. (New Jersey, 2001)

The New Jersey study also attempted to identify any differences in larval fish habitat in the surf zone caused by beach nourishment. A comparison of fish larva populations in the surf zone of a renourished area to the surf zone in an area of the designated study control zone suggested that no differences existed in fish larva (ichthyoplankton) abundance, size and species composition. The study, however, was unable to establish a direct beach to beach comparison between its designated study and control beaches because of the timing of the beach nourishment activities relative to the period of time in which sampling takes place. As a result, the significance of the findings may be limited. The New Jersey study further points out that adequate sampling of ichthyoplankton in the surf zone is difficult to achieve. The dynamic nature of a high-energy beach and the ever-changing and broad distribution of fish larvae make it difficult to identify anything but very large changes in ichthyoplankton density and composition.

4.3 Borrow Site

Sources of sand for beach nourishment can include upland sand deposits, estuaries, lagoons, inlets, sandy shoals dredged to clear channels for navigation and deposits in the nearshore area. The most common source of sand used in nourishment projects is nearshore deposits.

Physical changes that occur with nourishment: Borrow site conditions during and following dredging will vary depending upon the equipment and techniques used. A 1995 review of studies examining the environmental effects of beach nourishment indicates that few studies have been conducted of the long-terms changes in the depth, sediment composition and shape of the ocean floor of nearshore borrow areas. (NRC, 1995) Of the studies included in the review, most found that average sand grain size in the borrow area decreased after dredging, resulting in a higher silt/clay composition. This increase in the concentration of silty materials occurs as the finer, silt particles tend to go into suspension as the borrow area is dredged. These particles are slow to fall out of suspension, resulting in increased turbidity. Also, although little data exists measuring

the rate at which borrow sites refill, general observations indicate that, in cases where a deep hole is created, borrow areas tend to fill in slowly.

Effects on biota in borrow site: One concern with dredging a nearshore borrow site is that dredging may remove benthic species along with the sand, which may affect other species that rely on the benthos as a food source. Restoration of benthic species generally occurs as organisms from surrounding areas migrate back into the borrow area; however, the initial size and distribution of the new benthic community may be significantly different from the original community. For example, in the New Jersey study, a decrease in the abundance, biomass and size of sand dollars was noted in the borrow area after dredging. While the abundance of sand dollars was restored quickly after dredging occurred, the biomass required 2 – 2.5 years to recover. The diminished sand dollar biomass could be attributed either to the selective removal of older, mature sand dollars with dredging, or to the recolonization of the borrow site by smaller specimens (New Jersey, 2001)

With the exception of the period of recovery required for sand dollar populations, the findings of the New Jersey study indicate that all other infaunal assemblages monitored recovered within one year after dredging. The New Jersey study also looked for changes in the composition and abundance of finfish in the borrow area following dredging. As measured by catch-per-unit effort, no significant difference in species composition or abundance of finfish was found. The New Jersey study also monitored the feeding habits of winter flounder and summer flounder. No changes were detected in either winter or summer flounder foraging before, during or after borrow site dredging.

Dredging also churns up the fine, silty sediments on the ocean floor. If these sediments remain in suspension and increase water turbidity, they can inhibit phytoplankton photosynthesis by blocking out the sunlight. Increased turbidity can also interfere with filter feeders. When the ratio of suspended sediments to edible plankton is increased, filter feeders obtain less edible material per filtering effort. Additionally, extreme levels of turbidity may simply clog or damage the gills and filtering capabilities

of filter feeders. (Adriaanse, 1991) Increased turbidity can also interfere with the hunting success of fish and birds that rely on sight to capture their prey. (Adriaanse, 1991)

Corps projects utilize a variety of management practice to avoid turbidity in the borrow site area. Turbidity is monitored during dredging. Practices to minimize turbidity vary depending upon the site conditions. In some cases, use of a suction dredge without a cutterhead may reduce the amount of sedimentation created. In some cases, only one hopper dredge is operated at a time, to avoid excessive sedimentation in the water. Also, dredging operations may move back and forth along a long, linear strip, instead of creating a large, round pit in one area. Moving along a linear path while dredging avoids creating a sustained sediment plume in a single area. Borrow site selection is also critical in avoiding detrimental environmental effects. The borrow site is selected as far away from sensitive habitat as possible. Additionally, a buffer zone is established around any nearby reefs to protect from damage, either by physical contact or by increased turbidity.

Chapter 5
Summary and Findings

The President's proposed FY 2003 formula called for reversing the percentages to generally require 35 percent of the re-nourishment project costs to be funded by the Federal government and 65 percent from the non-Federal sponsor. The new formula would not only be applied to recommendations for authorizations of future re-nourishment projects, but it would also be applied to those projects that have been authorized but not completed and existing projects with continuing re-nourishment requirements. This was proposed to more appropriately reflect the distribution of economic benefits that shore protection projects provide to State and local sponsors. In addition, the Administration wants to ensure that the Federal government's long-term nourishment obligations do not "crowd-out" other important Federal expenditure needs.

The purpose of this study is to evaluate the distribution of both the national and regional economic development benefits of a shore protection project. The NED benefits considered included storm damage reduction benefits, recreation benefits, and other NED benefits (i.e., reductions in maintenance and emergency costs). RED benefits of shore protection are defined as the change in "value added" (i.e., the sum of employee compensation, proprietors' income, property income, indirect business taxes) resulting from subsequent recreational activities associated with alternative project plans adjusted for commuters' income, tax revenue transfers, and local beach management and maintenance costs. In order to provide support for the Administration's proposal to increase the local share of the costs for the beach re-nourishment component of shore protection, the following questions were addressed,

- Who benefits from shore protection projects?
- What is the distribution of project benefits?
- Do increases in tax revenues that stem from Federal shore protection projects affect the capacity of non-Federal sponsors to pay for the projects?

5.1 The Distribution of NED Benefits of Shore Protection Projects

NED benefits are distributed as follows in this study: storm damage reduction benefits are distributed according to the residence patterns of the affected property owners, recreation benefits are distributed by the residence patterns of the beach users, and other NED benefits are assigned to the area outside the beach region (i.e., the rest of the nation).

The distribution of shore protection benefits was analyzed using a hypothetical new beach new nourishment project that has a dry beach area above the mean high water level component that is one mile long by 100 feet wide. Quantities of sand were estimated that would not only create the "dry sand" component but also would extend out into the near shore area for storm damage protection, functional stability, and recreation. It was determined that the amount of sand needed to provide the appropriate level of shore protection varies according to the intensity of wave action on the beach. A quantity of sand (600,000 cubic yards) was used for the hypothetical beach nourishment project to reflect a "medium" energy beach. Average annual benefits per cubic yard of sand for each of the NED benefit categories (i.e., for storm damage reduction, recreation, and other NED benefits) were estimated based on sand quantities and benefits for a sample of completed and authorized Corps beach nourishment projects. Storm damage reduction benefits and other NED benefits were based on the total amount of sand used for the hypothetical new nourishment project. Recreation benefits were based on the quantity of sand used for the "dry sand" portion of the nourishment project. The NED benefits for each benefit category of the hypothetical nourishment project were estimated by multiplying the estimated quantities of sand by the average annual benefits per cubic yard of sand for completed and authorized Corps shore protection projects. Total estimated average annual NED benefits for the hypothetical project are estimated to be $1.65 million ($920,000 for storm damage reduction benefits, $609,000 for recreation benefits, and $123,000 for other NED benefits). Not having access to empirical data for a real beach nourishment project, the parameters concerning the proportion of property owner and beach users residing in the beach region were estimated based on data for a coastal

county reflecting a "typical" regional setting. The residential patterns were either estimated with data from the 2000 Census of Population or borrowed from selected past studies of beach economies. Based on the NED benefit estimates above and the derived beach parameters, it is estimated that approximately one-third of the NED benefits accrue to the beach region and two-thirds to the rest of the nation.

Two other coastal regions were chosen to provide the residential patterns for property owners and beach users for simulation purposes. These regions were selected to provide a range of parameter values that reflect a much more "rural" beach region and a much more "urban" beach region. When the type of region in which the beach is located is considered (i.e., the residential patterns of property owners and beach users are different for the "typical", rural, and urban beach regions), the distribution of NED benefits differs to some extent. The findings indicate that approximately half of the NED benefits accrue locally for the rural beach region and about 40 percent of the NED benefits would accrue locally to the urban beach region. Given the variability found here, it is extremely important to understand that the distributional patterns of the NED benefits for shore protection projects depend on the residential patterns of the property owners and the beach users. These patterns are specific to each community and, as a consequence, the distribution of NED benefits is also site-specific for each project. It should be noted that the NED benefit estimates for the "low" energy beach were smaller than for the hypothetical nourishment project and larger for the "high" energy beach, as would be expected, because the NED benefit estimates were related to the quantity of sand. However, the distribution of benefits between the beach region and the rest of the nation did not change much.

The effect of increased beach visitation due to the nourishment project on the distribution of NED benefits was evaluated; increases in visitation considered were 0, 5, 10, 15, 20, and 25 percent. Increases in visitation are partially based on the capacity of the hypothetical beach nourishment project. In addition, only real increases in visitation on peak visitation days are attributed to NED benefits. Corps District staff reported a variety of "unit-day" and "travel cost" method values that have been used when visitation

is expected to increase due a beach nourishment project; "beach experience" values have typically varied between $2 and $5 under the "with project" conditions. However, another Federal agency indicated that their unit-day values for beach experiences are in the $15 to $20 range. Increases in visitation raised the level of NED benefits but had little effect on the distribution of NED benefits, regardless of the unit-day value.

5.2 The Distribution of RED Benefits of Shore Protection Projects

RED benefits are distributed to the beach region and to the rest of the nation according to the net value added impacts that occur in each of the respective regions due to spending of tourists at the beach. However, the net value added impacts that occur in each region are measured from each region's point of view. Consequently, the RED benefits for the beach region are the net value added impacts within the beach region due to spending by all beach visitors residing outside the beach region. The RED benefits for the rest of nation are those net value added impacts occurring in the rest of the nation due to beach spending by foreign beach visitors only.

The RED analysis was carried out under several assumptions. First, it is assumed (for RED only) that the unemployment rate is not zero. This has the effect of permitting resources to flow between regions without negative impacts to occur in locations where the resources originated. Second, it is assumed that people's propensity to consume out of their incomes does not change due to the existence of a beach or because of a nourishment project. This means that the money spent at the beach will be spent whether a beach exists or not. If the beach is not available, then the users will spend their money on something else. The assumption also implies that any impacts (jobs, income, etc.) that might occur due to beach spending will occur in any event. At the local level, an exception to this assumption occurs when local beach users substitute going to a local beach for visits to beaches located outside the beach region. On a national level, foreign visitors may change the length of stay within the country or not come the U.S. at all (i.e., spend less money within the U.S.) if beaches are not available.

The net value added impacts (or RED benefits) for both the beach region and the rest of the nation were computed using a regional input-output analysis of recreational spending by visitors to the beach. To simulate the net value added effects of the existing beach on the economies of the beach region and the "rest of the nation" region, the net value added effects of one million beach visits per year by outside tourists during the year were evaluated. The decision to use "one million" beach visits by outside tourists was made to simulate the importance of the existing beach on the economy of the respective region and to demonstrate the procedures that were used to compute the net value added impacts and their distribution between the beach region and the rest of the nation.

On average for the "typical" region, it is estimated that one million outside beach visitors annually spend $88.1 million within the beach region. Of that total, $49.9 million is a direct economic stimulus to the beach region economy. The cumulative economic "ripples" created by the direct stimulus result in an estimated total economic impact on local businesses of $71.5 million per year. In addition to other economic resources required for these economic "ripples" to occur, a total of almost 2,000 full-time jobs are created annually who are paid an estimated $25.5 million in wages and salaries. Total value added (or gross regional product) created per year by these economic changes is $48.3 million. It is estimated that the local workers who commute from places outside the beach region take $5.8 million of the value added with them. Also, it is estimated that $12.3 million in State and Federal taxes accrue each year outside the beach region. The beach community is estimated to incur just under $2.0 million in beach management and maintenance costs annually to support the beach activity. All together, the net value added effect on the beach region is $28.2 million. Computed in a similar fashion, the net value added effect on the rest of the nation due to beach spending by foreign tourists is estimated to be $31.9 million annually. Taken together, approximately 47 percent of the RED benefits or net value added effects are expected to accrue to the "typical" beach region and 53 percent to the rest of the nation. However, if the beach had been located in the rural region then approximately 40 percent of the RED benefits would accrue locally, while half of the RED benefits would accrue locally if the beach were in the urban region.

The effects on the distribution of RED benefits due to increases in visitation stemming from the hypothetical new beach nourishment project were analyzed; specifically resulting from incremental increases in beach visitation of 0, 5, 10, 15, 20, and 25 percent. It is assumed that increases in visitation are based on the capacity of the hypothetical beach nourishment project. However, instead of only considering increases in visitation during peak visitation days (for NED benefits), increases in visitation for the entire year are evaluated for RED benefits. Because input-output is mathematically "linear", all impacts resulting from increases in visitation are proportional to the change in visitation relative to existing visitation levels (i.e., one million outside beach visits). Consequently, the magnitude of the net value added effects increases in proportion to the increase in beach visitation, however, the distribution of RED benefits does not change

A number of beach officials have indicated that beach visitation may not initially change as beaches are not nourished and allowed to erode. However, it appears that the mix of beach visitors and activities do change. It has been casually observed that the new visitors use the beaches differently; they use the beach more during low tide and less during high tide, they camp more and stay in "expensive" hotels and motels less; they dine in restaurants less frequently, etc. These changes mean that "fewer" dollars flow into the beach economy and the RED effects are smaller as a consequence. These effects were simulated by determining what would happen if the outside beach visitors to the "typical" beach region behaved like the outside beach visitors to the rural beach region. That is, rather than the million outside beach tourists now spending $88.1 million per year, they will spend $66.7 million per year. It is also assumed that the pattern of expenditures will change accordingly. Relative to the "typical" situation, the drop in spending by outside tourists will mean a drop in RED benefits by $8 million both for the beach region and for the rest of the nation.

5.3 Local Fiscal Effects of Beach Nourishment Projects

Local tax revenues generated by recreation-related activities at existing beaches may be larger than required to fund related beach management and maintenance costs. The implication is that beaches have more than enough money to fund the additional non-Federal cost-share for the beach re-nourishment component of the shore protection program. However, even if local tax revenue collected are greater than needed to cover beach management and maintenance costs, the "excess" revenues are probably being currently used to help fund other important local public services and, therefore, they may not readily available to fund an increase in the non-Federal cost-share.

However, the local tax revenues that are collected as a result of "new" beach visitation due to the hypothetical beach nourishment project could be used to fund the increased non-Federal cost share. The non-Federal cost share of 65 percent of the project costs as recommended in the President's FY'02 budget was calculated by applying an assumed "cost-benefit" ratio of 2.0 to the estimated total NED benefits that result from increases in visitation due to the hypothetical beach nourishment project; increases in visitation considered are 0, 5, 10, 15, 20, and 25 percent. There are various methods that non-Federal sponsors use to fund their share of the project costs. One method of funding the non-Federal cost share is to "float" a municipal bond to be paid for in annual increments over a period of time (for example, 20 years). The total cost of the bond includes not only the principle (i.e., the non-Federal cost share) but also the interest that would accrue for the period of the bond. The bond is assumed to have a 5 percent annual interest rate compounded annually (the September 2001 rate of interest for 20-year State and local general obligation bonds is 5.09 percent). If no "new" visitation is induced by the hypothetical beach nourishment project or if the quality of the beach experience is not improved, then there will be no additional local tax revenues available to fund any of the non-Federal cost-share (even to cover the existing 35 percent cost share requirement). Under the increased visitation scenarios for the "typical" beach region, annual excess local tax revenues collected would be less than the annual cost of a bond to fund the increased non-Federal share of the hypothetical project costs for all increases of visitation

considered. Even if the "typical" beach region's project benefit/cost ratio was as large as 3.0, the annual excess local tax revenues are still less than the annual cost of the bond for the "typical" beach region. If the State in which the beach and the "typical" region are located paid 75 percent of non-Federal cost-share (as some States do), the annual excess local tax revenues would still be less than the annual bond cost for 25 percent of the non-Federal cost-share. Even if a 50 percent non-Federal cost-share were instituted and the State paid 75 percent, the annual excess local tax revenues would be less than the annual cost of the bond for any increase in visitation considered (0, 5, 10, 15, 20, and 25 percent).

Note that annual local tax revenues in the rural region are estimated to be less than annual beach management costs for all increases in beach visitation. Therefore, there are no expected excess local tax revenues collected to help fund the non-Federal share of project costs in these areas. In addition, urban regions would also be unable to pay for the entire non-Federal cost-share based on the annual excess local tax revenues collected due to any of the increases in visitation considered. However, if the State participated in the hypothetical beach nourishment project and pays 75 percent of the non-Federal cost-share, then visitation will need to increase in the range of 15 to 20 percent in order for the annual excess local tax revenues to be greater than the annual bond cost (if the non-Federal cost-share is 65 percent for the urban region). If the non-Federal cost-share is 50 percent and the State pays 75 percent, then beach visitation would need to increase in the range of 10 to 15 percent before annual excess local tax revenues are greater than the annual bond cost for the urban region.

Finally, if the hypothetical beach nourishment project were not implemented and the beach were allowed to erode initially, there appears to be concern that the fiscal conditions within the beach region might degrade; not so much because visitation will decline but because spending by tourists will decline. If, for example, outside beach visitors to the "typical" beach region were to spend and behave similar to those in a rural region, then the amount of local tax revenues collected will drop. In this case, they are estimated to drop to a level just above that needed to cover the beach management and

maintenance costs. It is not asserted that these changes reflect any actual events. However, they might reflect the possible concerns of public officials responsible for managing and maintaining beaches.

5.4 Environmental Effects of Beach Nourishment Projects

Periodic re-nourishment of beaches often has beneficial environmental effects. Many Corps beach nourishment projects have produced environmental benefits, such as providing new nesting area for sea turtles, spawning grounds for horseshoe crabs, and habitat for piping plover, least terns and seabeach amaranth.

The studies included in this overview generally indicated limited and short-lived impacts of beach nourishment activities in the subaerial zone, subtidal zone and borrow site, when appropriate management practices are exercised, as established by Corps regulations and guidelines. The plant and animal species existing in littoral areas are adapted to survive in the dynamic environment created by the natural cycle of sand erosion and accretion. While in the short-term, beach nourishment can result in physical changes to the beach environment; Corps engineering guidelines specify the use of engineering and monitoring practices to avoid detrimental impacts. Practices employed by Corps engineers include planting beach plants to replace damaged plants and create pedestrian barriers, conducting construction activities in the fall and winter season to avoid interfering with nesting and spawning season for nearshore and beach animals, using sand that is closely matched to sand on the existing beach, establishing buffer zones around reefs and other sensitive habitats near the borrow site to prevent damage from turbidity or physical contact during dredging, monitoring turbidity levels and implementing dredging operations designed to minimize turbidity.

None of the studies reviewed attempted to distribute the incidence of any beach nourishment environmental impacts between the local community and the rest of the nation. There are also, however, financial costs associated with environmental considerations made during beach nourishment activities. Such considerations include

the monitoring of a nourishment project to identify possible environmental impacts. There are also costs associated with any special measures taken to protect environmental resources such as the examples given above. The costs associated with these types of environmental considerations are distributed between the non-federal sponsor and the federal government according to the cost-share arrangement established for the project.

5.5 Conclusions

- **Due to the sensitivity of the estimated shares of NED and RED benefits that accrue locally, it is important not to "generalize" the results provided here.** The findings here depend on the specific parameter values that are used in the analysis. These parameters have been chosen from selected studies of beach economies. Also, the regions used in the analysis, although real coastal counties that contain beaches, are chosen based their representative characteristics of average, rural, and urban coastal counties. Specific results and conclusions of the present study may change substantially with better information. The shares of NED and RED benefits that accrue locally could be computed on a "case-by-case" basis when projects are evaluated. A more comprehensive study of the distribution of the benefits of shore protection projects could be undertaken with one of its purposes to produce more general results than provided here.

- **National cost sharing decision should not be made based on the subjective findings and hypothetical situations portrayed in this study.** The analysis included many assumptions and hypothetical scenarios in order to demonstrate a methodology that could be used to analyze individual beach project situations, if pertinent data could be developed and collected. The methodology appears to warrant further development and application in establishing a reasonable distribution of shore protection benefits in regard to where beneficiaries live and the origin of visitors to the beaches.

- **For the "typical beach area" considered and the geographic distributions of the primary residence of beach property owners and beach users, approximately 35 percent of the national economic development benefits (storm damage reduction benefits, recreation benefits, and other NED benefits) from a beach nourishment project accrue to people within the beach region and 65 percent accrue to people who reside elsewhere.** The "typical" beach region was used because it reflected an average regional setting for which the great majority of Corps shore protection projects are located. However, considering more rural or more urban beach settings (regions), higher percentages of NED benefits (as high as 50 percent for a rural beach region) were found to accrue to people locally. Examining the business opportunities related to associated recreational activities, about 47 percent of the regional economic development benefits accrued to people residing in the "typical" beach region and

53 percent elsewhere. The local percentage of RED benefits varied between 40 and 50 percent for the rural and urban regions considered.

- **Periodic beach re-nourishment often has beneficial environmental effects.** Many Corps beach nourishment projects have produced environmental benefits, such as providing new nesting area for sea turtles, spawning grounds for horseshoe crabs, and habitat for piping plover, least terns and sea-beach amaranth.

- **The most current and comprehensive monitoring of the environmental effects of beach nourishment projects indicate that nourishment projects have no significant impacts in the long-run, when appropriate management practices are exercised, as established by Corps regulations and guidelines.** The plant and animal species existing in littoral areas are adapted to survive in the dynamic environment created by the natural cycle of sand erosion and accretion.

- **Properly engineered and constructed beach nourishment projects avoid potential adverse environmental impacts.** In doing the literature search for this study of the potential environmental consequences of nourishment projects, it became apparent that the Corps has developed extensive expertise and general procedures for avoiding potential adverse environmental consequences due to the many years of experience in designing and constructing these types of projects.

- **While beach nourishment does accelerate certain dynamic processes that can tax the capacity of species to adapt, Corps engineering guidelines specify the use of engineering and monitoring practices to avoid detrimental impacts.** Practices employed by Corps engineers include planting beach plants to replace damaged plants and create pedestrian barriers, conducting construction activities in the fall and winter season to avoid interfering with nesting and spawning season for near shore and beach animals, using sand that is closely matched to sand on the existing beach, establishing buffer zones around reefs and other sensitive habitats near the borrow site to prevent damage from turbidity or physical contact during dredging, monitoring turbidity levels and implementing dredging operations designed to minimize turbidity

- **With no increase in recreation visitation induced by a project and when there is no improvement in the quality of the beach experience, the increase in regional benefits is zero.** Many Corps feasibility studies anticipate no increase in tourism that satisfies unmet recreational demand with a Federal shore protection project. The regional economic benefits are tied to the related expenditures that beach visitors bring to the beach community. Without new infusions of money, there will be no regional economic impacts induced by a shore protection project.

- **The impact of a hypothetical one million recreation visitors from outside the beach region was shown in order to provide a perspective of the existing value of tourism to beach communities with approximately 2-3 million in**

total annual visitations. The analysis of the hypothetical million outside recreation visitors was also to demonstrate and test the methodology used to evaluate the regional economic development benefits of shore protection projects.

- **Increases in recreation visitation induced by a beach nourishment project generate corresponding increases in potential regional economic benefits.** Increases in visitation in the of 0 to 25% were found to result in potential regional economic gains in the range of 0 to 10.7%

- **All 5 states surveyed participate in cost sharing the non-Federal share of Federal and even local projects.** However, the extent to which States participate in cost sharing with the non-Federal sponsors of shore protection projects varies. There are also a wide variety of funding mechanisms used by States and local communities to fund the non-Federal share of shore protection projects.

Given the variability of NED benefits for shore protection that accrue locally, it is extremely important to understand that the distributional patterns of the NED benefits for shore protection projects depend on the residential patterns of the property owners and the beach users.

- **The fiscal capacity of State and local sponsors to fund the President's proposed 65 percent non-Federal share of re-nourishment costs will not improve if beach nourishment projects do not increase beach visitation or if the quality of the beach experience is not improved.** Beaches that do not experience increases in visitation as a result of nourishment projects will not experience any regional economic impact because lack of new visitation will not generate any new spending for recreation. Local tax revenues, one of the impact elements affected beach visitor spending, will also not change. As a result, no additional funds would be available to help fund any increases in the non-Federal cost-share.

- **Although increases in visitation at beaches located within "typical" beach regions due to beach nourishment will likely increase annual local tax revenues above the needs for beach management and maintenance, the increases in annual "excess" local tax revenues are unlikely to be large enough to fund an increased non-Federal cost-share from the current 35 to 50 percent to 50 or 65 percent of the project re-nourishment costs, even if the State participates by paying as much as 75 percent of the non-Federal cost-share.**

- **Additional and creative funding mechanisms, other than existing local taxes and fees systems, may be needed to help beach communities fund their portion of any proposed increases in non-Federal cost-shares, even if the State would pay a significant portion of the increased share of project costs.** The large majority of the Corps' beach nourishment projects are located in regions that most like the "typical" beach region in this report and very few of the

beach region would be categorized as either "rural" or "urban" when defined as in this report.

- **Urban regions may be capable of funding the proposed increased non-Federal cost-share with beach visitation increases in the range of 10 to 20 percent if the State participates in paying a significant portion of the non-Federal cost-share.** However, few of the past, current, or authorized Corps beach nourishment projects are located in regions that might be classified as "urban": for example, urban beach regions would include Miami Beach, Fl, Virginia Beach, VA, northern New Jersey shore and Long Island, NY in the vicinity of New York City, and a few others.

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Appendix A
Shoreline Protection and Beach Erosion Control Authorizing Legislation

1. **An Act Authorizing General Shoreline Investments at Federal Expense, PL 79-166, 31 July 1945.** This Act established authority for the Beach Erosion Board to pursue a program of general investigation and research and to publish technical papers.

2. **Section 14, River and Harbor Act of 1946, PL 79-526, 24 July 1946.** Section 14 authorized emergency bank protection works to prevent flood damage to highways, bridge approaches, and public works.

3 **An Act Authorizing Federal Participation in the Cost of Protecting the Shores of Publicly Owned Property, PL 79-727, 13 August 1946.** This Act authorized Federal participation up to one-third (⅓) of the cost, but not the maintenance of protecting shores of publicly owned property.

4 **PL 84-71, 15 June 1955.** Specifically authorized studies of the coastal and tidal areas of the eastern and southern U.S. with reference to areas where damages had occurred from hurricanes.

5 **PL 84-99, 28 June 1955.** This Act authorized an emergency fund for flood emergency preparation, flood fighting and rescue operations or for repair or restoration of flood control work threatened or destroyed by flood.

6 **PL 84-826, 28 July 1956.** Section 1© defines periodic beach nourishment as "construction" for the protection of shores, when it is the most suitable and economical remedial measure. Section 1(d) provided for Federal assistance to privately owned shores if there is benefit from public use or from protection of nearby public property.

7 **Section 203, River and Harbor Act of 1958, PL 85-500, 3 July 1958.** This section added provisions of local cooperation on three hurricane flood protection projects that established an administrative precedent for cost sharing of hurricane projects. Non-Federal interests were required to assume thirty (30) percent of total first costs, including the value of land, easement and rights of way, and the operations and maintenance of projects.

8. Section 103, River and Harbor Act of 1962, PL 87-874, 23 October 1962.

Shore Protection: Section 103 amended Section 3 of the Act approved 13 August 1946, as amended by the Act approved 28 July 1956 and indicated the extent of

Federal participation in the cost of beach erosion and shore protection (50 percent of the construction cost when the beach is publicly owned or used, and 70 percent Federal participation for seashore parks and conservation areas when certain conditions of ownership and use of the beaches are met)—these provisions are modified by the provisions of PL 99-662.

Small Beach Erosion Projects: Authority for the Secretary of the Army to undertake construction of small beach and shore protection projects was also established under Section 103.

9. PL 99-172, 7 November 1963. Section 1 abolished the Beach Erosion Board and established the Coastal Engineering Research Center.

10. Sections 111 and 215, River and Harbor and Flood Control Act of 1968, PL 90-483, 13 August 1968.

Section 111: This section authorized investigation and construction of projects to prevent or mitigate shore damages resulting from Federal navigation works, at full Federal cost limited to $1,000,000 per project. Amended 17 November 1986 by Section 915(f) and 940, PL 99-662 that, among other things, increased the limit on Federal costs per project to $2,000,000.

Section 215: This section authorized reimbursement (including credit against local cooperation requirements) for work performed by non-Federal public bodies after authorization of water resource development projects. Execution of a prior agreement with the Corps was required and reimbursement was not to exceed $1,000,000 for any single project. Amended by Section 913 PL 99-662 and by Section 12, PL 100-676 to increase the limit on reimbursements per project.

11. Sections 12 and 208, River and Harbor and Flood Control Act of 1970, PL 91-611, 31 December 1970.

Section 12: This section increased the limit on Federal costs for small beach erosion projects from $500,000 to $1,000,000. The annual authorization limit was also raised to $25,000,000. Limits have subsequently been raised further (most recently by PL 99-662).

Section 208: This section authorized discretionary modifications in Federal participation in cost sharing for hurricane protection projects.

12. Section 55, Water Resources Development Act of 1974, PL 93-251, 7 March 1974. Section 55 authorizes technical and engineering assistance to non-Federal public interests in developing shore and stream bank erosion.

13. Sections 145 and 156, Water Resources Development Act of 1976, PL 94-587, 22 October 1976.

Section 145: This section authorized the placement of sand obtained from dredging operations on adjacent beaches if requested by the interested state government and in the public interest—with the increased costs paid by local interests. Amended by Section 933, PL 99-662, to allow for Federal funding of 50 percent of the increased costs. This section was further amended by Section 207 of PL 102-580 to permit agreements for placement of fill on beaches to be with political subdivisions of a state.

Section 156: This section authorizes the Corps to extend Federal aid in periodic beach nourishment up to 15 years from date of initiation of construction. Amended by Section 934 of PL 99-662 to allow for extension of up to 50 years.

14. Sections 103, 933, 934, and 940, Water Resources Development Act of 1986, PL 99-662, 17 November 1986.

Section 103: Section 103 establishes new non-Federal cost sharing requirements of 35 percent for hurricane and storm damage prevention and 50 percent for separable recreation.

Section 933: This section modifies Section 145 of PL 94-587 to authorize 50 percent Federal cost sharing of the extra costs for using dredged sand from Federal navigation improvements and maintenance efforts for beach nourishment.

Section 934: Section 934 modifies Section 156 of PL 94-587 to authorize the Corps to extend aid in periodic nourishment up to 50 years from the date of initiation of project construction.

Section 940: This section amends Section 111 of PL 90-483 to allow implementation of non-structural measures to mitigate shore damages resulting from Federal navigation works; to require local interests to operate and maintain Section 111measures; and to require cost sharing of implementation costs in the same proportion as for the works causing the shore damage.

15. Section 206, Water Resources Development Act of 1992, PL 102-580, 31 October 1992. Under this section, non-Federal interests are authorized to undertake shoreline protection projects on the coastline of the United States, subject to obtaining any permits required pursuant to Federal and State laws in advance of actual construction and subject to prior approval of the Secretary of the Army.

16. Section 640, Water Resources Development Act of 1996, PL 104-303, 31 December 1996. Under this section the Secretary may select a disposal method that is not the least cost option if the incremental costs are reasonable in relation to the environmental benefits, including wetlands development and shoreline erosion control. The law clarifies shore protection policy to maintain a Federal in

shoreline and beach protection and restoration, including the use of periodic beach nourishment. The law also established a National Shoreline Erosion Control Development and Demonstration Program (not funded).

17. Sections 215 and 217, Water Resources Development Act of 1999, PL 106-53, 17 August 1999.

Section 215: This section modifies Section 103(d) of WRDA'86 by changing the non-Federal share of periodic nourishment costs to 45 percent after 1 January 2002 and to 50 percent after 1 January 2003. This is for projects in reports authorized for construction after these dates.

Section 217: This section modifies Section 145 of WRDA'76 by changing 50 percent to 35 percent.

Appendix B
Income Components of U.S. Gross Domestic Product, 1996
(Billions of dollars)

Compensation of employees	4,426.9
Wage & salary accruals	3,633.6
Disbursements	3,632.5
Wage accruals less disbursements	1.1
Supplements to wages & salaries	793.3
Employer contributions for social insurance	385.7
Other labor income	407.6
Proprietor's income with inventory & capital consumption adjustments	
Rental income of persons with capital consumption adjustment	
Corporate profits with inventory valuation & capital consumption adjustments	735.9
Corporate profits with inventory valuation adjustment	674.1
Profits before tax	676.6
Profits tax liability	229.0
Profits after tax	447.6
Dividends	304.8
Undistributed profits	142.8
Inventory valuation adjustment	-2.5
Capital consumption adjustment	61.8
Net interest	
National Income	**6,254.5**
Business transfer payments	33.6
To persons	26.0
To the rest of the world	7.6
Indirect business tax & non-tax liability	604.8
Less: Subsidies less current surplus of government enterprises	25.4
Consumption of fixed capital	830.1
Private	682.7
Government	147.4
General government	125.1
Government enterprises	22.3
Gross National Income	**7,697.6**
Less: Receipts of factor income form the rest of the world	234.3
Plus: Payments of factor income to the rest of the world	232.6
Gross Domestic Income	**7,695.9**
Statistical discrepancy	-59.9
Gross Domestic Product	**7,636.0**

Source: U.S. Bureau of Economic Analysis (BEA) *A Guide to the NIPA's: Methodology, National Income and Product Accounts, 1929-1997*. Washington, DC: U.S. Department of Commerce (June 2001).

Definition of Terms

Compensation of employees is the income accruing to employees as remuneration for their work. It is the sum of wage and salary accruals and of supplements to wages and salaries.

Wage & salary accruals consist of the monetary remuneration of employees, including the compensation of corporate officers; commissions, tips, and bonuses; voluntary employee contributions to certain deferred compensation plans, such as 401(k) plans; and receipts in kind that represent income. Wage and salary accruals consist of ***disbursements*** and ***wage accruals less disbursements***. Disbursements are wages and salaries as just defined except that retroactive wage payments are recorded when paid rather than when earned. Accruals less disbursements is the difference between wages earned, or accrued, and wages paid, or disbursed. In the NIPA's, wages accrued is the appropriate measure for national income, and wages disbursed is the appropriate measure for personal income.

Supplements to wages & salaries consist of employer contributions for social insurance and other labor income. ***Employer contributions for social insurance*** consist of employer payments under the following Federal and State and local government programs: Old-age, survivors, and disability insurance (social security); hospital insurance; unemployment insurance; railroad retirement; government employee retirement; pension benefit guaranty; veterans life insurance; publicly administered workers' compensation; military medical insurance; and temporary disability insurance. ***Other labor income*** consists of employer payments (including payments in kind) to private pension and profit-sharing plans, private group health and life insurance plans, privately administered workers' compensation plans, supplemental unemployment benefit plans, corporate directors' fees, and several minor categories of employee compensation, including judicial fees to jurors and witnesses, compensation of prison inmates, and marriage fees to justices of the peace.

Proprietor's income with inventory & capital consumption adjustments are the current-production income (including income in kind) of sole proprietorships and partnerships and of tax-exempt cooperatives. The imputed net rental income of owner-occupants of farm dwellings is included; the imputed net rental income of owner-occupants of non-farm dwellings is included in rental income of persons (described below). Proprietors' income excludes dividends and monetary interest received by non-financial business and rental incomes received by persons not primarily engaged in the real estate business; these income are included in dividends, net interest, and rental income of persons.

Rental income of persons with capital consumption adjustment is the net current-production income of persons from the rental of real property except for the income of persons primarily engaged in the real estate business; the imputed net rental income of owner-occupants of non-farm dwellings; and the royalties received by persons from patents, copyrights, and rights to natural resources.

Corporate profits with inventory valuation & capital consumption adjustments are the net current-production income of organizations treated as corporations in the NIPA's. These organizations consist of all entities required to file Federal corporate tax returns, including mutual financial institutions and cooperatives subject to Federal income tax; private non-insured pension funds; non-profit institutions that primarily serve business; Federal Reserve banks; and federally sponsored credit agencies. With several differences, this income is measured as receipts less expenses as defined in Federal tax law. Among these differences: receipts exclude capital gains and dividends received, expenses exclude depletion and capital losses and losses resulting from bad debts, inventory withdrawals are valued at replacement cost, and depreciation is on a consistent accounting basis and is valued at replacement cost using depreciation profiles based on empirical evidence on used-asset prices that generally suggest a geometric pattern of price declines. Because national income is defined as the income of U.S. residents, its profits component includes and excludes income earned in the United States by the rest of the world.

Profits before tax are the income of organizations treated as corporations in the NIPA's except that it reflects the inventory- and depreciation-accounting practices used for Federal income tax returns. It consists of profits tax liability, dividends, and undistributed corporate profits.

Profits tax liability is the sum of Federal, State, and local income taxes on all income subject to taxes; this income includes capital gains and other income excluded from profits before tax. The taxes are measured on an accrual basis, net of applicable tax credits.

Profits after tax are profits before tax less profits tax liability. It consists of dividends and undistributed corporate profits. ***Dividends*** are payments in cash or other assets, excluding the corporations' own stock, that are made by corporations located in the United States and abroad to stockholders who are U.S. residents. The payments are measured net of dividends received by U.S. corporations. Dividends paid to State and local government social insurance funds and general government are included. ***Undistributed profits*** are corporate profits after tax less dividends.

Inventory valuation adjustment for corporations is the difference between the cost of inventory withdrawals as valued in the source data used to determine profits before tax and the cost of withdrawals valued at replacement cost. It is needed because inventories as reported in the source data are often charged to cost of sales (that is, withdrawn) at their acquisition (historical) cost rather than at their replacement cost (the concept underlying the NIPA's). As prices change, companies that value inventory withdrawals at acquisition cost may realize profits or losses. Inventory profits, a capital-gains-like element in profits, result from an increase in inventory prices, and inventory losses, a capital-loss-like element of profits, result from a decrease inventory prices. In the NIPA's, inventory profits of losses are shown as adjustments to business income (corporate profits and non-farm proprietors' income); they are shown as the inventory valuation adjustment with the sign reversed. No adjustment is needed to farm proprietors' income because farm inventories are measured on a current-market-cost basis.

Net interest is the interest paid by private business less the interest received by private business, plus the interest received from the rest of the world less the interest paid to the rest of the world. Interest payments on mortgage and home improvement loans and on home equity loans are counted as interest paid by business because home ownership is treated as a business in the NIPA's. In addition to monetary interest, net interest includes imputed interest, which is paid by corporate financial business and is measured as the difference between the property income received on depositors' or policyholders' funds and the amount of property income paid out explicitly. The imputed interest paid by life insurance carriers and non-insured pension plans attributes their investment income to persons in the period it is earned. The imputed interest payments by financial intermediaries other than life insurance carriers and private non-insured pension plans to persons, governments, and to the rest of the world have imputed service charges as counter entries in gross domestic product and in net receipts of factor income from the rest of the world; they are included in personal consumption expenditures, in government consumption expenditures and gross investment, and in exports of goods and services, respectively.

Business transfer payments consist of payments to persons and to the rest of the world by private business for which no current services are performed. Business transfer payments ***to persons*** consist primarily of liability payments of non-profit institutions. Business transfer payments ***to the rest of the world*** are non-resident taxes—taxes paid by domestic corporations to foreign governments.

Indirect business tax & non-tax liability consists of (1) tax liabilities that are chargeable to business expense in the calculation of profit-type incomes and (2) certain other business liabilities to general government agencies that are treated like taxes. Indirect business taxes include taxes on sales, property, and production. Employer contributions for social insurance are not included. Taxes on corporate incomes are not included; these taxes cannot be calculated until profits are known, and in that sense, they are not a business expense. Non-taxes includes regulatory and inspection fees, special assessments, fines and forfeitures, rents and royalties, and donations. Non-taxes generally exclude business purchases from general government agencies of goods and services that are similar to those provided by the private sector. Government receipts from the sales of such products are netted against government consumption expenditures.

Subsidies less current surplus of government enterprises. Subsidies are the monetary grants paid by government agencies to private business and to government enterprises at another level of government.

The ***current surplus of government enterprises*** is their current operating revenue and subsidies received from other levels of government less their current expenses. In the calculation of their current surplus, no deduction is made for net interest paid. The current surplus of government enterprises is not counted as a profit-type income, and therefore, it is not counted as a factor charge. Subsidies and current surplus are shown as a combined entry because deficits incurred by some government enterprises may result from selling goods to business at below-market prices in lieu of giving them subsidies.

Consumption of fixed capital is a charge for the using up of private and government fixed capital located in the United States. It is based on studies of prices of used equipment and structures in resale markets. For general government and for non-profit institutions that primarily serve individuals, it is recorded in government consumption expenditures and in personal consumption expenditures, respectively, as the value of the current services of the fixed capital assets owned and used by these entities. ***Private capital consumption allowances*** consist of tax-return-based depreciation charges for corporations and non-farm proprietorships and of historical-cost depreciation (calculated by BEA using a geometric pattern of price declines) for farm proprietorships, rental income of persons, and non-profit institutions. ***Private capital consumption adjustment*** is the difference between private capital consumption allowances and private consumption of fixed capital.

Receipts of factor income form the rest of the world consist of receipts by U.S. residents of interest and dividends, of reinvested earnings of foreign affiliates of U.S. corporations, and of compensation paid to U.S. residents by foreigners.

Payments of factor income to the rest of the world consist of payments to foreign residents of interest and dividends, of reinvested earnings of U.S. affiliates of foreign corporations, and of compensation paid to foreigners by U.S. residents.

Statistical discrepancy is an "income" component that reconciles the income product sides of the NIPA's. It arises because the two sides are estimated using independent and imperfect data.